

[0033] FIG. 3 shows alternative locations for the rail passage 48 and the oil passage 46 within the shaft 32. Although it is known to provide the oil passage 48 through the rocker shaft 32 in existing fuel systems, due to the requirement for the additional passage 48 to be provided through the rocker shaft 32 to define the rail volume 12, the oil passage 46 must be of smaller diameter and displaced off-centre from the shaft axis to ensure there is sufficient space available for the passage 48.

[0034] The rocker shaft 32 may also be provided with various oil drillings (not shown) in a conventional manner, which permit lubricating oil to be supplied to rocker arm bearings and the pumping element 18 of the unit injector 10 from the passage 46.

[0035] As it is necessary to provide the rocker shaft 32 in the engine for a purpose other than defining the rail volume 12, it is a particular advantage of the present invention that there is no requirement for an additional common rail component within the fuel system as an existing part of the engine is utilised for this purpose. By defining the rail volume 12 within the existing rocker shaft component of the engine a considerable advantage is obtained in terms of accommodation space. The common rail component of a fuel system is also a particularly heavy component and so the elimination of this housing part altogether from the engine, by defining the rail volume within an already existing component, provides a significant weight and cost advantage also.

[0036] The invention is particularly applicable to hybrid unit injector-common rail fuel systems, as described previously, where the pressure demands for the rail volume are reduced due to the ability of the unit injectors 10 to increase rail pressure to higher injection pressures by virtue of their dedicated pumping elements 18 and rail control valves. The rail volume 12 can therefore be defined within a component having relatively thin walls, such as the rocker shaft 32.

[0037] The invention is equally applicable, however, to systems where the rail volume 12 supplies fuel to the injectors but in which there is no additional pumping element 18 in the injectors to increase fuel pressure above rail pressure. The invention therefore applies equally to more conventional common rail fuel systems in which rocker arms are provided on a rocker shaft 32 for controlling operation of the inlet and/or exhaust valves of the engine cylinders only, but in which no third rocker arm (e.g. rocker arm 30) is required.

[0038] The invention is also applicable if the injectors take the form of unit pumps, which have a dedicated pumping element for increasing fuel pressure above rail pressure, but where the associated injector for each pumping element is spaced remotely from its pumping element, the pump and injector components being connected by a high pressure fuel line.

[0039] In another embodiment of the invention, the rocker shaft 32 may be provided with a plurality of accumulator volumes, each of which is defined by a separate passage and/or internal volume within the shaft 32 and is arranged to supply fuel to a different one or more of the injectors of the associated fuel system.

[0040] In yet another embodiment of the invention, and as indicated by the dashed feature identified by 112 in FIG. 1,

instead of defining the rail volume 12 within the rocker shaft 32, the rail volume 112 may be defined within the engine cylinder head 16. Again, as the rail volume 112 is integrally formed within an already existing part of the engine, there is no need to provide a separate rail volume component and, hence, the aforementioned weight and cost advantages are obtained. The fuel system of this embodiment may be provided with any of the aforementioned types of injector or unit pump.

1. An accumulator fuel system for an internal combustion engine having a plurality of engine cylinders, the fuel system including:

an accumulator fuel volume (12; 112) for supplying high pressure fuel to one or more of a plurality of injectors (10), each of which is arranged to supply fuel to an associated one of the engine cylinders,

wherein the accumulator fuel volume (12; 112) is integrated within an engine component provided for a purpose other than that solely of an accumulator fuel volume for storing high pressure fuel.

2. The accumulator fuel system as claimed in claim 1, wherein the system includes a rocker shaft (32) upon which a rocker member is pivotally mounted, wherein the rocker member is arranged to control one or more inlet and/or exhaust valves of an associated engine cylinder and wherein the accumulator fuel volume (12) is integrated within the rocker shaft (32).

3. The accumulator fuel system as claimed in claim 2, wherein the rocker shaft (32) is provided with a first axially extending passage (46) for receiving a lubricating fluid and a second axially extending passage (48) defining the accumulator fuel volume (12).

4. The accumulator fuel system as claimed in claim 2 or claim 3, including the fuel injectors, wherein the accumulator fuel volume (12) is arranged to supply fuel at a first pressure level to one or more of the plurality of injectors (10), and wherein each injector includes an additional pumping plunger (20) for pressurising fuel to a second pressure level higher than the first pressure level.

5. The accumulator fuel system as claimed in claim 4, including a first rocker member for controlling one or more engine cylinder inlet valves, a second rocker member for controlling one or more engine cylinder exhaust valves and a third rocker member (30) for transmitting drive to the pumping plunger (20) of the associated injector (10), wherein the first, second and third rocker members are pivotally mounted upon the rocker shaft (32).

6. The accumulator fuel system as claimed in claim 4 or claim 5, wherein the rocker shaft (32) has a longitudinal axis which is arranged to extend substantially perpendicular to a longitudinal axis of the pumping plunger of (20).

7. The accumulator fuel system as claimed in any one of claims 4 to 6, wherein the injectors are electronic unit injectors (10).

8. The accumulator fuel system as claimed in any one of claims 4 to 6, wherein each injector is associated with an electronic unit pump for increasing fuel pressure to the second pressure level.

9. The accumulator fuel system as claimed in claim 1, wherein the fuel system includes an engine cylinder head (16) within which a plurality of engine cylinders are defined, and wherein the accumulator fuel volume (112) is an integral part of the engine cylinder head (16).